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TRANSFER AND USE OF TRAINING TECHNOLOGY IN AIR FORCE TECHNICAL TRAINING

A MODEL TO GUIDE TRAINING DEVELOPMENT

HUMAN RESOURCES RESEARCH ORGANIZATION
ALEXANDRIA, VIRGINIA

OCTOBER 1976

Transfer and Use of Training Technology in Air Force Technical Training:

A Model to Guide Training Development

Edgar M. Haverland

HUMAN RESOURCES RESEARCH ORGANIZATION
300 North Washington Street • Alexandria, Virginia 22314

Final Scientific Report for Period 1 August 1973 - 31 August 1976

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The training development process was studied as it was applied in six different training development efforts in Air Force technical training settings over a period of eight months. A previously developed model for matching training approaches with training settings was revised, and suggestions were made for its use in training development efforts. A number of general comments on training development in Air Force technical training are included in the report.

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SUMMARY AND IMPLICATIONS

Objective

The objectives of the work described in this report have been to examine carefully the training development process, as it is carried out in Air Force technical training settings, and to revise the model for matching training approaches with training settings so that its usefulness to Air Force training developers is increased.

Approach

The approach taken in this work was to select six training development efforts being carried out in Air Force Schools of Applied Aerospace Sciences, discuss these efforts with the personnel involved periodically over a period of eight months, and obtain training documentation as it became available.

The six training development efforts selected were:

(1) Air base ground defense courses, Lackland AFB

(2) Electronic fundamentals portion of course on maintenance of cryptographic equipment, Lackland AFB

(3) Intermediate level maintenance courses for F 15 avionics systems, Lowry AFB

(4) Materiel control aircraft/ICBM course, Lowry AFB

(5) Modularized instructional system development course, Sheppard AFB

(6) Transportation officer course, Sheppard AFB

The previously developed model was based on the concepts of "training approach" and "training setting", which were intended to include all factors that should be considered in developing training. The concept of training approach includes any method, technique, device, or system considered for use in training. The concept of training setting covers all elements of the training agency or establishment, including resources, policies, training content and student characteristics. The format of this version of the model involved two parallel sets of questions, one set dealing with the training approach and the other set with the training setting.

Results

The revision of the model involved three major changes:

(1) Consolidation of the two sets of questions into one set, for brevity and more flexible usage. The concepts of training approach and training setting are retained in using the model.

(2) Division of the model into Stages I and II, corresponding respectively to early activities in the training development process, which culminate in the Training Plan, and to the actual development of plans of instruction, lesson plans, study guides, etc.

(3) Addition of specific guidance on the implications of different kinds of training content for choosing training approaches.

In addition, some general observations were made on practical exigencies of the training development process, as it was observed in operation, and on the backgrounds of Air Force training developers and their perceptions of the policies and constraints within which they work.

The revised model is presented, with suggestions for its use in Air Force training development efforts.

PREFACE

This report describes work performed by the Human Resources Research Organization under Research Project AFTEC, Basic Research Relevant to Air Force Technical Training, for the Air Force Office of Scientific Research.

The research was conducted at HumRRO's Eastern Division, Alexandria, Virginia. Dr. J. Daniel Lyons is Director of the Division, and Dr. Edgar M. Haverland is principal investigator for the project. Other work in the project has been done at HumRRO's Western Division at the Presidio of Monterey, California.

The cooperation of Headquarters, Air Training Command, Randolph AFB; and of the Schools of Applied Aerospace Science at Lackland AFB, Sheppard AFB, and Lowry AFB is gratefully acknowledged.

This project has been conducted for the Air Force Office of Scientific Research (AFOSR) under Contract No. F44620-74-C-0007. This report has been submitted to AFOSR as a Final Scientific Report.

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Chapter 1

INTRODUCTION

This is the concluding report on a project entitled, "Basic Research Relevant to U.S. Air Force Technical Training," which has been supported by the Air Force Office of Scientific Research under Contract No. F44620-74-C-0007. The project has been focused generally on the training development process, and has sought to facilitate the effective use of training technology by developing a model for evaluating training approaches or innovations against the requirements and constraints of particular training settings. This model is referred to as the "AFTEC model."

Phase I of the project began 1 August 1973 and ended 31 August 1974. In this phase an initial version of the AFTEC model was developed and subjected to criticism by Air Force training developers and designers in the Technical Training Centers. The revised model incorporating these criticisms is presented in a Technical Report (Haverland, 1974) which describes the activities and accomplishments of Phase I of the project.

Phase II of the project extended from 1 September 1974 to 31 August 1975. During this phase of the project it was planned to use the AFTEC model to select a training setting (course) in which to implement the peer instruction training approach (Weingarten, Hungerland and Brennan, 1972). However, the peer instruction training approach became the object of intense interest by Air Force training agencies, and in order to sustain and satisfy this interest, the selection of the course and the development of the peer instruction system was accelerated and given high priority. The result was that the model was not used to select the course, and the peer instruction part of the project took on a life of its own. Late in Phase II the work of the project was separated into two parallel sub-projects; one dealing with the implementation of the peer instruction system in the Communication Center Specialist Course (3ABR29130) in the School of Applied Aerospace Sciences at Sheppard AFB, and one in which further work with the AFTEC model was undertaken. Most of the effort in Phase II was spent on the peer instruction work. Activities and accomplishments during Phase II are described in more detail in an Interim Scientific Report (Haverland and Hungerland, 1975).

Phase III of the project has extended from 1 September 1975 to 31 August 1976. During this period the work with the peer instruction system was completed and has been reported separately (Hungerland, Taylor and Brennan, 1976). The work with the AFTEC model during Phase III is the subject of this report.

Objective

The general objective of the project has been to facilitate the effective use of training technology through the development of a model for matching training approaches or innovations with specific training settings. The specific objectives of Phase III activities in the project have been to examine closely the training development process as it is carried out in Air Force technical training, and to revise the AFTEC model so that its usefulness to Air Force training developers is increased.

Definitions

The first version of the AFTEC model was based on the two complementary concepts of training approach and training setting. In developing these concepts, an attempt was made to consider all the elements involved in training, and divide them into two categories; the training approach and the training setting.

The concept of training approach includes any method, technique, device or system considered for use in training. Examples of training approaches include the following: a self-paced learning system, a performance-oriented training system, a peer instruction system, a sound-slide system for instruction, performance testing, a learning center system utilizing carrels and modular instructional packages, the lecture method, the discovery method, and the Socratic method. More than one of these training approaches may be combined with performance testing on criterion objectives to yield an integrated and comprehensive training approach. As a further example, the peer instruction system (Weingarten, Hungerland and Brennan, 1972) includes thorogoing performance orientation of the learning activities, and performance testing, in addition to peer instruction.

The concept of training setting covers all elements of the training establishment, including resources, policies, training content, and student characteristics. A training setting can be defined to cover a whole course,

a major portion of a course, or a small segment of instruction dealing with a particular topic or skill, as may be appropriate for the particular training development situation. Elements of a training setting include:

(1) The financial, physical and personnel resources of the training organization: funds, buildings and equipment; and instructional and support personnel.

(2) Policies and requirements of the training agency, and of the organizations and commands it serves.

(3) The training content, as described in training objectives in the Plan of Instruction (POI), the list of tasks in the Training Standard (STS or CTS), or latent in the field requirements waiting to be investigated.

(4) The abilities, previous experence, physical characteristics, and attitudes of the students to be trained.

The AFTEC model consisted of questions that were designed to obtain information about the training setting, and to require the training developer to evaluate in a specific fashion how well the training approach being considered would "fit" the training setting. A training approach which fit or matched the requirements and constraints of the training setting was considered to be one that would be suitable to use in developing training for that setting.

Training development is considered to be a process that begins with the tentative decision to prepare or substantially revise a course of instruction, and proceeds through the activities of preparing the Training Plan, including a Training Standard and a Course Chart; and preparing the Plan of Instruction, tests, study guides, work books and lesson plans that finally define and embody the course. It involves primarily Step 4 of the Instructional System Development model (Plan, develop and validate instruction), but includes some of the activities of Step 2 (Define education or training requirements) and Step 3 (Develop objectives and tests).

In Phase I of the project the first version of the AFTEC model was initially constructed mainly with the varieties of possible training approaches in mind. When this version of the model was applied to training

settings, some difficulties were encountered, which are described in earlier project reports (Haverland, 1974; and Haverland and Hungerland, 1975). Consequently, in Phase III of the project, the emphasis has been shifted to the training setting, and the model revised to shape it in accordance with the realities of training settings in Air Force technical training.

Scope of This Report

This report describes the work done on the AFTEC model during Phase III of the project. The general approach taken in this work was to select six training development efforts at three different Schools of Applied Aerospace Science, and to observe the work of Air Force training developers, closely interacting with them and discussing the nature and problems of the training development process. From the information thus gathered from Air Force training developers, general observations and comments on Air Force training development will be presented. The modifications made in the model, from the Phase I version, will be discussed, and suggestions made for the use of the model. Finally, the revised version of the model is presented.

Chapter 2

SELECTION AND STUDY OF TRAINING DEVELOPMENT EFFORTS

Near the end of Phase II of the project, after the work with the AFTEC model was separated from the peer instruction work, an assessment of the status of the model showed that its applicability to training settings needed to be explored and developed. Efforts to apply the model to training settings had showed that a thorough-going application of the model to a training setting required a very large amount of information. The selection of the training setting (course) in which the peer instruction system was implemented had shown that certain critical factors sometimes virtually determined the choices made in training development efforts. And finally, applications of the model to training settings had shown that drawing inferences from the kinds of training content to the kinds of training approaches or methods that should be used involved uncertain and incomplete processes. These problems with the model are discussed in more detail in the Interim Scientific Report (Haverland and Hungerland, 1975, pp. 4-6).

Accordingly, it was planned that in Phase III of the project, a variety of training development efforts would be examined closely and the model revised to make its application to training settings more feasible and satisfactory.

Selection of Training Development Efforts

The following criteria were used in selecting six training development efforts to observe and work with in this project:

1. The training development effort was a real effort, Air Force personnel were working on it, and decisions were being made concerning training approaches to be used in actual training.
2. The Air Force personnel working on the training development effort were interested in this project and willing to have HumRRO personnel working with them.
3. At least one of the training development efforts should involve short, low-volume transient courses.

At the end of Phase II of the project and early in Phase III, visits were made to the Schools of Applied Aerospace Sciences at Lackland AFB,

Lowry AFB, and Sheppard AFB. Discussions were held with personnel in the Training Plans Sections of School Headquarters, and in the Curriculum Sections of several instructional departments. As a result of these discussions the following six training development efforts were selected:

1. Revision of three air base ground defense courses (3AZR81150-4, 3AZR81170-2, and 30ZR8124-1), in the Combat Studies Branch of the Department of Security Police Training, Lackland AFB.
2. Revision of the electronic fundamentals blocks of the course on maintenance of cryptographic equipment (3AQR30020-4), in the Department of Cryptographic Training, Lackland AFB.
3. Development of intermediate level maintenance courses for F-15 avionics systems (3ALR32630-2, 3ALR32631A-001, and 3ALR32631B-001) in the Avionics Aerospace Ground Equipment Training Branch of the Department of Avionics Training, Lowry AFB.
4. Development of the Materiel Control Aircraft/ICBM Course (3AZR64550-5) in the Department of Logistics Training, Lowry AFB.
5. Development of the modularized instructional system development course in the Instructor Training Division, Sheppard AFB.
6. Revision and development of the Transportation Officer Course (30BR6051) in the Traffic Management Branch of the Department of Transportation Training, Sheppard AFB.

Discussion of the Training Development Efforts

The revision of the air base ground defense courses was prompted by the threat of terrorist activities, and was being carried out under the pressure of intense high level interest (Air Force Chief of Staff). While the courses are not short or low-volume, this was a quick-reaction training development effort. As might be expected under such conditions, the usual, prescribed instructional development procedures were short-cut and many decisions concerning training approaches were made in conferences of representatives of Hq, USAF; Major Commands; Hq., ATC; and the Department of Security Police Training. The chief of the team charged with developing the revised courses requested additional copies of the Phase I version of the AFTEC model, and the model was used to some extent in the course development work.

The revision of electronic fundamentals training for cryptographic equipment maintenance was undertaken as a part of the general instructional system development program. Specifically, the aim was to get the content more precisely aligned with what was needed in the later blocks of the course, where the maintenance of particular pieces of cryptographic equipment was studied.

The intermediate level maintenance courses for F-15 avionics systems were being newly developed for a weapon-system that was just becoming operational. The training content was highly technical and the projected student volume was quite low. The maintenance concept for the F-15 avionics equipment (which had been decided upon early in the development of the weapon system) involves computerized malfunction isolation for some of the test equipment which was supposed to indicate to the maintenance technician the particular circuit boards that should be replaced. Accordingly, the technical orders did not contain the circuit diagrams, information on theory of operation, or test point data needed to troubleshoot <u>within</u> the circuit boards. Because of this lack of information in the technical orders, the training developers were forced to shift their preferred instructional content and learning activities mix of information and performance considerably in the direction of more performance on the equipment.

The Materiel Control Aircraft/ICBM course was intended to teach supply personnel in using commands, in this case those concerned with aircraft and missile operations, the information and procedures needed so that they could work efficiently with the Air Force Logistics Command installations which supply the operational commands with materiel. In this case, the training developers in the Department of Logistics Training were heavily dependent on personnel assigned from the operating commands, in developing the course.

The instructional system development course was intended to teach people how to carry out instructional system development procedures in detail. It was to be a modularized course so that people could study any or all parts of the course, according to their needs. During much of the time devoted to observing and studying training development efforts in this project, work on this course was at a standstill, awaiting the Occupational Survey Report.

The Transportation Officer Course being developed at Sheppard AFB was an integration of the 11 week Transportation Officer course which had been taught at Sheppard AFB, and a 7 week Vehicle Management Course which had been taught at Chanute AFB. The course was designed to teach a wide variety of information about all three of the major areas in the transportation field: traffic management, aerial ports (military airlift), and vehicle management. A few of the learning activities were of a performance nature, but most were designed to help students acquire and organize a large amount of information which they would need in their work as junior transportation officers.

Information Gathering Efforts

Trips were made by the principal investigator to Sheppard, Lackland, and Lowry AFB's in August, September, and November 1975, and in March 1976. One or two days were spent at each base on each trip. On these visits extended discussions were held with the persons who were working on each of the training development efforts. Also, sample documentation; such as training plans, training standards, course charts, plans of instruction, and workbook and study guide materials; was obtained from the course developers as it became available.

From these discussions a considerable amount of information was obtained about the people who develop or revise instruction in Air Force technical training. In addition a good deal was learned about the organizational influences and constraints which affect their work. This information has served as a background for efforts to revise the AFTEC model so that it would be more useful to Air Force training developers. Some general observations on training development, as it is carried out in Air Force technical training, are also offered.

Observations on Training Development

It was noted previously that decisions on the maintenance concept for the F-15 avionics equipment, made earlier in the development of the weapon system, had constrained the training developers' choices of training content and approaches. Ironically, when the computerized malfunction isolation in some of the complicated test equipment did not prove satisfactory, it was necessary to develop revised Technical Orders which provided circuit

diagrams and information on theory of operation, and circuit board extenders so that maintenance technicians could locate and repair malfunctions within individual circuit boards. Accordingly, it was necessary also to revise some of the training, after it had been developed and implemented. Generally, this appears to be a problem involving larger scale procedures for developing major weapons systems, and would not be soluble at the level of the training development process.

The typical airman or officer at the working level in Air Force training development has come to this position with a combination of field experience in the specialty and experience as an instructor in the School. Civilians will usually have served as an instructor in the School, but may not have had field experience, except perhaps some years earlier during military service. Airmen and officers will often have been students in courses similar to those they are developing, but usually this student experience will be five to fifteen years old.

The repertory of training methods and approaches available to most training developers is limited to those he or she has experienced as a student, on the job in the field, or as an instructor in the School. Therefore the usual tendency is to develop training in the image of the training he or she has experienced as a student and instructor, conditioned of course by currently applicable regulations.

A number of training developers have been exposed to different instructional methods and approaches, some in non-military technical schools or community colleges, and some in college courses in education or instructional technology. However, their perception usually is that there is little freedom to introduce innovations into Air Force technical training, because of the several levels of evaluation and approval (usually traditionally oriented) which their proposed training materials must pass. These levels of approval start at the department curriculum unit and go on up the hierarchy.

Occasionally, a decision will be made at a high level (Headquarters, Air Training Command) that, say, self-pacing is a desirable feature in training, and Schools will be urged to self-pace their courses. When this is done, and the word gradually permeates the inspection and evaluation

elements of the Headquarters, the pressure on the Schools to fall in line becomes intense. This often leads to uncritical acceptance and implementation of the suggested instructional approach, sometimes in an inferior form, and sometimes in an inappropriate setting.

The ideal would be to have training developers acquainted with a wide range of possible training approaches, and to have them free to judiciously apply these approaches in the training they develop. They should be guided mainly by reasonable cost limitations and the effectiveness of the resulting training. The training developers encountered in this study were skilled and conscientious. Knoweldge of a wider range of possible instructional approaches and freedom to responsibly choose among these approaches would enable them to do a better job of developing training.

distinct stages. Stage I of the process involves the preliminary planning in which the number of students to be trained, the major resources needed, and a general outline of the training content are decided upon. The product of Stage I of the training development process is a Training Plan, usually including a Course Chart and a Training Standard. The procedures and requirements for Training Plans are described in ATCM 52-1 (Air Training Command, 1969). Following the completion of the Training Plan there is usually a period during which higher level approvals of the training plan and authorizations to proceed with the preparation of detailed training materials are obtained. Then Stage II activities are undertaken. These Stage II activities involve preparation of a detailed Plan of Instruction, lesson plans, study guides, work books, etc.

An examination of the Phase I version of the AFTEC model showed that it involved both Stage I and Stage II training development activities, mingled together with no recognition of the two-stage process described above. Accordingly, the revised version of the model presented in this report is divided into two stages. The kinds of questions involving numbers of students, major resources needed, and the general outline and content of the training to be developed are placed in Stage I of the model, and the questions concerned with the activities of instructional personnel, the characteristics of students, and the specific implications of the training content for the kinds of learning activities that should be provided in the training are placed in Stage II.

Specifically, the question in the training content section of Stage I of the model which asks,

> "What tasks must the student be able to perform when he finishes training and to what level of proficiency must the student perform on each task? What kinds of knowledge about each task should the student have?"

refers to the preparation of the list of tasks for the training standard.

Addition of Guidance on Implications of Training Content for Training Approaches.

Problems in inferring from the kinds of training content to the kinds of training approaches that should be used were noted in the Interim Scientific Report (Haverland and Hungerland, 1975, pp. 5-6). Gagne (1970) has

Chapter 3

REVISION OF THE AFTEC MODEL

The Phase I version of the AFTEC model (Haverland, 1974) consisted of two parallel sets of questions. One set of questions dealt with the training approach being considered, and the other set with the training setting. The questions covered such topics as the objectives sought in developing or revising the training, the resources (funds, materiel and facilities, and personnel) required, instructional design and management, the characteristics of the training content and the characteristics of the students.

Consolidation of the Questions Into One Set

The two parallel sets of questions in the Phase I version of the model covered the same topics, one set being worded so as to focus attention on the requirements and implications of the training approach being considered, and the other set worded so as to focus attention on the resources and personnel available in the training setting, and on the requirements and constraints that the training setting would impose on the training to be developed. In fact, in nearly all cases, corresponding questions on the two "sides" of the model were paraphrases of each other. This format was used in an attempt to require the training developer to use the concepts of training approach and training setting, and to seek a match between them as the method of making decisions concerning the general form that the training to be developed should take.

This two-sided format produced a bulky and repetitive model. The format of the model presented in this report has been revised so that it consists of one set of questions, with attention being directed to the training approach and the training setting by space for notes concerning the training approach on the left side of the page, and space for notes concerning the training setting on the right side of the page.

Division into Stages I and II

Observation of the training development process in Air Force technical training showed that the activities involved are often divided into two

attempted to provide general guidance for making these kinds of inferences, and Air Force guidance on this problem, AF Pamphlet 50-58 (Department of the Air Force, 1973), follows Gagne. Training content, and the kinds of training approaches that should be used, are discussed in AFP 50-58 (Volume IV, Chapter 3) using the following categories:

Motor Chains
Verbal Associations and Chains
Discriminations
Classifications
Rule - Using
Problem-Solving

However, these classifications of performance are several degrees of abstraction removed from the kinds of performance required of students, as perceived by Air Force training development personnel.

In discussions with training development personnel, it was found that only one or two of the most sophisticated and better educated persons were familiar with and able to use this set of classifications in deciding on the kinds of training approaches to use for various kinds of training content. For most training development personnel, the degree of abstraction involved in this set of classifications was apparently too great for them to be able to use it in classifying the training content they were dealing with, and then to go on and follow the suggestions for deciding on the training approaches to be used.

Gagne and Briggs (1974) use a set of categories that is even more general and abstract.

In the Phase I version of the AFTEC model the attempt was made to make the categories suggested for classifying training content more concrete by making them somewhat less general and all-inclusive. Also, these categories were labeled with words that were somewhat less abstract, and which had been used in the literature on task descriptions. In addition, two or three specific examples of each type of performance were given. This still left the training developer with no guidance as to the most important features of each kind of content, to which he should give careful consideration in deciding on training approaches. In the latest version of the AFTEC model, as presented in this report; brief, pointed discussions of each type of

training content are added. In these discussions the most important features, for the training developer, of each type of training content are pointed out, and explicit suggestions are made as to how these features should influence the choice of training approaches. This still falls considerably short of a logic tree or decision table method of indicating the kinds of training approaches that should be used for particular kinds of training content, to which some training developers wishfully referred.

It is the writer's opinion that a logic tree or decision table method of deciding on training approaches for particular kinds of training content would be unlikely to cover some of the various possible training approaches that might be feasible in different training settings. If such a method were presented, training developers would likely lean on it, and fail to consider training approaches that might be quite feasible in their training setting but not in many others.

General Comments on the Revised Model.

The revised AFTEC model has been tailored to fit training development process, as it was observed in Air Force technical training settings, in many small ways, in addition to the change to a two-stage procedure, which has already been discussed. These small changes are mainly in terminology, since in conversations with Air Force training developers, frequent questions were encountered about training technology terminology which differed from that in general use in the Air Force. The Phase I version of the AFTEC model had been constructed with potential applications in civilian education and training in mind, and this sometimes led to the use of terminology different from that used in the Air Force.

However, one of the subordinate objectives of this project has been to stimulate and extend the thinking of Air Force training developers, so that they will consider a wider range of training approaches than they usually do now. To this end, the revised model has retained a number of features which go bevond common practice in current Air Force training development. These features appear in questions which ask about instructor roles in managing the learning activities of students and in quality assurance performance testing, for example. Other questions deal with features

of training approaches not in common use in the Air Force, such as peer instruction.

In developing the Phase I version of the AFTEC model, it had been assumed that detailed and specific training objectives would be available, and that the use of the model would be only in training development activities downstream from this point in the whole process. Observation of the six training development efforts showed that much of the information that the model dealt with was gathered earlier in the training development process. Hence the shift to a two-stage process, with all of the Stage I activities occurring before detailed specific training objectives are written. Actually, it appeared that detailed, specific training objectives are usually hammered out in the process of writing the Plan of Instruction. To be sure, lists of objectives are prepared at earlier stages of the process, in accordance with instructional system development procedures in AF Manual 50-2 (Department of the Air Force, 1975), but the final objectives that actually characterize the instruction in operation are fashioned in the confrontation between what is desired and what is feasible, which occurs during Stage II of the training development process, as it is described above. Accordingly, it is now assumed that in analyzing training content in Stage II, training developers will be working from the list of tasks which had been developed in Stage I for the Training Standard, and will fashion the training objectives as an early part of actually developing the training in Stage II.

In observing Air Force training development efforts, it was observed that a major distinction is made between task performance and task or subject knowledge. This grows out of the prescribed proficiency codes used in the training standards. However, it appears to have major effects on the later choices of instructional and testing methods. For tasks that are given a performance proficiency code in the training standard, it appears that training developers will make substantial efforts to devise methods of teaching and testing that require students to actually perform the activity involved, or something close to it. However, for tasks that are given a knowledge proficiency code, there appears to be much less pressure to train and test in ways that are job-relevant. Information will often

be presented in lectures that might better have been taught in the context of the job activities for which it is needed, and knowledge tests that do not relate the information to the situations on the job where it is needed are often used. The result is that often the training and testing are less effective than they could be.

In dealing with training content in Stage II of the revised AFTEC model, a heavy emphasis is placed on performance. Knowledge is prominent only in one of the types of training content (Recall and application of facts), and to some extent in Problem Solving, but in both cases the guidance offered emphasizes that the knowledge must be taught in a job-relevant context.

Chapter 4

USING THE MODEL

The revised AFTEC model can be used in several different ways. At one level, it can be used as a general reminder-checklist of things to consider in a training development effort. Stage I of the model would be used, of course, in the activities leading to the development of a training plan, and Stage II in the later, actual development of training materials.

At an entirely different level, the model may be used as a full-fledged procedure for evaluating a proposed training approach or system against the requirements and constraints of a particular training setting. When the model is used at this level, the suitability of the proposed training approach in the particular training setting should be carefully evaluated with respect to each question in the model, and detailed notes and comments written down. A review of these notes and comments will then show the points on which the training approach appears to be particularly suited for use in this training setting, and the points where there may be difficulties or doubts about the suitability or feasibility of the proposed training approach in this training setting. The decision on whether to go ahead and implement the training approach in this training setting may then be made, based on a consideration of these points.

In addition the model may be used as an outline for discussing the features of a training approach in general, and not with respect to a particular training setting. The questions in the model have been selected because they involve points that are important in evaluating the suitability of a training approach for use in training settings. Therefore, these questions should bring out the features of a training approach that are likely to be important in determining how well it works when applied in an actual training setting.

Finally, the model may be used as an outline, if one wished to develop a relatively complete inventory and description of a training setting. For this purpose the model will serve as a good guide to the features of a

training setting that are important for the kinds of training methods or approaches that may be useful in that training setting.

Critical Factors in a Training Setting

In observing training development efforts, it has been noted that there are times when a single factor in a training setting may have extraordinary weight in decisions that are made concerning training appraoches. Major equipment or facility shortages, pressure from a higher level headquarters, or the costs of going to a third or fourth shift training operation are possible examples of such factors.

It is suggested that an effort be made early in any training development project to identify any factors which are likely to have extraordinary influence on decisions made during the training development process. The AFTEC model may be useful in this effort, since it covers many factors that are usually important in training development decisions. However, unusual circumstances may exist, so that a factor that ordinarily would not be of great importance may be very important in this particular training setting. Thus certain courses of action may be practically dictated, or certain training approaches ruled out, in the beginning, by the weight that such an unusual factor has in the training setting. It is recommended that the proposed training development effort be carefully reviewed by a person who is quite familiar with resources, policies, and personalities of the training setting, to see whether any such critical factors are present. The model can be reviewed with this objective in mind, but an effort should be made to go beyond the model and identify any unusual factors that may be of great importance in this particular training setting.

If one or more unusually important factors are identified, their probable influence on training development decisions should be estimated. Then the more detailed analyses, using the model, can be modified accordingly. Detailed analyses involved in certain decisions may not need to be done, if the decisions have in effect already been made, based on some unusually important factors in that particular training setting.

Comparison of the AFTEC Model with the MODIA System

The MODIA system (A Method of Designing Instructional Alternatives) is a comprehensive, highly computerized model for designing instructional systems, and particularly for evaluating by simulation the consequences of decisions concerning alternative features of instructional systems. The MODIA system has been developed over the last several years by the Rand Corporation, and according to recent unpublished working notes, it has grown in complexity during this period. By contrast, the revised version of the AFTEC model presented in this report has been simplified and tailored more closely to the terminology and structure of current training development efforts in Air Force technical training.

It appears to the writer that the MODIA system will require, in addition to substantial computer capacity, a corps of experts in the method (referred to as "the MODIA team"), and extensive orientation to the system of a large group of subject matter experts cum training developers who are dispersed throughout the instructional departments of Air Force Schools. This orientation will need to focus specifically on the sets of categories established in the MODIA system for the types of learning events, subject matter, teaching formats, etc., so that these persons can supply suitable input materials to the MODIA team, and then make constructive use of the output from the system. Thus, implementing the MODIA system will require a very substantial training and orientation effort. The present version of the AFTEC model is designed specifically to be useful to present training developers in Air Force technical training settings, working under present conditions, and should not require any special training and only a minimum of orientation.

Chapter 5

THE REVISED MODEL

The revised model is presented in this final chapter. The reasons for the revision, and a discussion of the differences between the revised model and the Phase I model (Haverland, 1974) are presented in Chapter 3 of this report. Suggested uses for the model are presented in Chapter 4.

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STAGE I

Stage I of the model is intended to be used early in the process of planning and developing training. It deals generally with the kinds of questions that must be answered in developing a Training Plan, according to ATCM 52-1 (Air Training Command, 1969). The activities involved in answering the questions in Stage I of the model include developing the list of tasks for the Training Standard, and blocking out the major sections of the training course to be developed, as in a Course Chart.

The following is an outline of the major headings in Stage I of the model:

OBJECTIVES

RESOURCES
- A. Funds
- B. Instructional equipment, materials, and facilities

INSTRUCTIONAL DESIGN AND MANAGEMENT
- A. Instructional pacing and individualization
- B. Fixed, standard level of proficiency expected of each student
- C. Requirements for Management information

INSTRUCTIONAL PERSONNEL
- A. Number of instructors needed
- B. Skills or experience needed by instructors

STUDENT CHARACTERISTICS
- A. Numbers of Students
- B. Students from foreign countries, or other Services

TRAINING CONTENT
- A. Performance and knowledge requirements
- B. Organization of training content
- C. Appropriate kinds of instructional activities
- D. Frequency and extent of likely changes in training content

STAGE I

Notes on Training Approach

Notes on Training Setting

OBJECTIVES

What are your objectives in developing or revising this training? What goals would you like to see the training system attain? What problems do you see in the training system that need to be solved? The following list describes some goals that might be achieved in developing or revising this training. Others should be added if needed.

- Improve job performance of graduates
- Reduce student attrition
- Individualize training
- Save training time
- Reduce training costs
- Adapt course to students of lower (or higher) aptitude
-
-

RESOURCES

A. Funds

1. Will capital expenditures, for such items as new or renovated buildings or training equipment, be necessary in developing or revising this training?

2. What operating expenses, such as maintenance of equipment and facilities or consumable supplies, will be required for the training to be developed?

3. What are the training development expenses likely to be for such activities as job analysis, training content analysis, development of training system, and development of the training materials), both originally and whenever changes in training content or policies make it necessary to partially repeat the training development process?

4. Can the training to be developed share facilities or equipment with other courses, or with operational units?

Notes on Training Approach		Notes on Training Setting

B. Instructional equipment, materials, and facilities

1. What types or locations of training are involved in the training to be developed? Possible types or locations of training are listed below. Others should be added to this list, if they are needed.
   - Formal school training, of a continuing nature
   - Special school training, of a one-time nature
   - Basic military training
   - On-the-job training
   - Learning Resource Center
   - Dispersed locations
   - Remote sites
   -
   -

2. Space required for training

   a. What kinds of space are needed for the training to be developed? How much of each kind of space is needed? Examples of kinds of space:
      - Classroom
      - Laboratory
      - Practical exercise facilities
      - Outdoor ranges or maneuver areas
      - Storage
      -
      -

   b. Does the training to be developed require that the space to be used have special characteristics or utilities? Examples:
      - Electric power requirements
      - Air conditioning and ventilation requirements
      - Lighting requirements
      - Floor loading capacity
      -
      -

   c. Are environmental extremes, such as heat, cold, humidity, etc., likely to be a problem in the training to be developed?

Notes on
Training Approach

Notes on
Training Setting

d. What elements in possible training approaches are related to space needs? Possible elements include:
- One classroom for each Class of ____ students
- One terminal for each student using the system
- One learning station for each module of content
- One set of equipment for each group of students
-
-

3. Equipment and Materials

a. What kinds and amounts of equipment from the field will be needed to conduct the training? Does this equipment need to be operational, or can it be non-operational?

b. What kinds and amounts of training equipment or materials will be needed for the training? The following list suggests some kinds of training equipment and materials that may be needed:
- Audio-visual equipment
- Films
- Audio and video tapes
- Training aids (charts, transparencies, cut-away equipment, mock-ups, etc.)
- Part-task training devices
- Simulators, of various fidelity levels
- Study guides, Technical Orders, or other printed training material.
- Job performance aids.
-
-

c. Can the training to be developed be accomplished in a manner so that some equipment now on hand can be turned in?

4. Factors affecting the management of instructional equipment and materials.

a. What resources (funds, skilled personnel, tools and equipment, etc.) will be needed to maintain the equipment to be used in the training?

b. Will training materials or equipment with security classifications be needed to conduct the training?

c. Will it be necessary to use copyrighted materials in the training? If permission is needed, can it be obtained?

d. What are the lead times required to obtain the equipment that will be needed to conduct the training?

e. Will printing of training materials, or production of other audiovisual materials be necessary to support the training being planned? Is base (or other) support available for these things? With what lead time?

INSTRUCTIONAL DESIGN AND MANAGEMENT

A. Instructional pacing and individualization

1. How will the progress of individual students through the instruction be determined? The following list describes some alternative methods for pacing instruction:
   - Lock step: All students follow a fixed schedule
   - Group pacing: Students progress through the instruction at a rate determined by the abilities of a group as a whole. Groups of homogeneous ability levels may be formed (multiple tracks).
   - Individual or self-pacing: Each student may proceed at his or her own pace through the required training activities.

2. Depending on the answer to Question 1 above:

   a. If the course of training is to be of a fixed length for all students, how long is it to be?

   b. If the course of training is to be of a variable length for different students, what limits on variation in course length (if any) should be set?

Notes on
Training Approach

Notes on
Training Setting

3. Will students be given the opportunity to take proficiency tests covering modules or sections of the training content, and if they pass these proficiency tests, will they be allowed to skip the training activities for these modules and move on to other parts of the instruction? This feature is termed, variously, proficiency advancement, modular scheduling, or diagnostic proficiency individualization.

4. Will extra training materials or activities be provided for some portion of the students, so that they can remedy deficiencies in their preparation for the instruction?

5. Will students have a choice (at least part of the time) as to the methods or media they use in studying the training content?

B. Is a fixed, standard level of skill or proficiency expected of graduates of the training to be conducted, or is each student expected to develop his capabilities as far as he can in areas at least partly determined by his own interests?

C. Will it be necessary to gather, summarize and report various kinds of management information for the training to be developed? Have the requirements for privacy and confidentiality of such information been considered? The following list indicates some of the kinds of management information that might be required:

- Information on students' backgrounds
- Information on students' progress through the training
- Information on the adequacy of various parts of the training
- Information on the adequacy of graduates' performance
- Information on instructional resource utilization
-
-

INSTRUCTIONAL PERSONNEL

A. Number of instructors needed

1. Considering the relevant Trained Personnel Requirement (TPR) and the plans for managing student learning activities, how many instructors will be needed to present and manage the training being developed?

2. In planning for the development of the training, has adequate lead time been allowed for obtaining instructors?

B. What skills or experience should be possessed by the instructors who will be needed for the training to be developed? Some of the skills or experience that might be needed are given in the following list; other kinds should be added if needed:
   - Proficiency in the subject matter students are to learn
   - Managing instructor-student relationships (classroom management skills, reinforcement techniques, counseling techniques, etc.)
   - Analyzing and critiquing student performance
   - Relevant field experience
   - Proficiency in instructional system development activities
   - Operation of audiovisual equipment
   - Computer operation or programming
   - Writing skills
   - Proficiency in evaluating student performance
   - Knowledge of relevant administrative systems
   - Operation or maintenance of operational equipment
   -
   -

STUDENT CHARACTERISTICS

A. Numbers of Students

1. According to the relevant Trained Personnel Requirement (TPR) how many students are to be trained per Fiscal Year?

2. Will these students be divided into groups or classes? If so, what size will the groups or classes be, and at what intervals will they enter the training? Or will students enter the training in a more or less continual flow?

3. Do student input rates, or the characteristics of the available physical facilities have implications for the size of the basic instructional group (that is; classroom, laboratory or work group)?

4. Will the supply of students available to enter the training likely be stable, or will it probably fluctuate sharply?

B. Are some of the students from foreign countries, or from other Services?

TRAINING CONTENT

A. Performance and knowledge requirements

1. What tasks must the student be able to perform when he finishes training, and to what level of proficiency must the student perform each task? What kinds of knowledge about each task should the student have?

a. Task performance standards:
   - Limited performance-can do simple parts of the task, but needs to be told or shown how to do most of the task.
   - Partial performance-can do most parts of the task but needs help on the hardest parts of the task.
   - Competent performance-can do all parts of the task and needs only to be spot-checked.
   - Highly proficient performance-can accomplish the complete task quickly and accurately, and can tell or show others how to do the task.

b. Task knowledge standards:
   - Nomenclature-can name parts, tools and simple facts about the tasks.
   - Procedures-can name the steps in doing the task and tell how each step is done.
   - Operating principles-can explain why and when the task must be done, and why each step of the task is needed.
   - Complete theory-can predict, identify and resolve problems about the task.

2. General knowledge standards. What kinds of general knowledge about the subject involved in the training should students have when they finish training?
   - Facts-can cite basic facts about the subject
   - Principles-can explain relationships among basic facts and state general principles about the subject.
   - Analysis-can analyze facts and principles and draw conclusions about the subject.
   - Evaluation-can evaluate conditions and make proper decisions about the subject.

B. Organization of Training Content

1. Division into blocks or modules

   a. Are there, within the training content itself, natural divisions that should be considered when dividing the training into blocks or modules?

   b. Does the training approach being considered provide a basis for dividing the training into blocks or modules?

   c. Are physical facilities, such as classrooms, laboratory space, and operational or training equipment, arranged in a manner that would affect the division of training into blocks or modules?

2. Sequencing of training content

   a. Must some parts of the training content be learned before other parts can be learned?

   b. Does the training approach being considered have any implications for the sequencing of training content?

   c. Is there a need for a flexible sequence of training activities (if this is feasible) in order to be able to work around bad weather or equipment failures, for example?

C. What kinds of instructional activities appear to be appropriate for the training to be developed? Examples of several kinds of instructional activities are given in the following list (others should be added if they are needed):

- Demonstration (presentation of performance)
- Practice of performance
- Presentation of knowledge
- Practice of knowledge
- Provision of feedback, or knowledge of results, to students
- Provision of individual, tutorial assistance to students
- Evaluation of student performance and knowledge

D. Is the training content likely to change frequently or substantially after the training has been developed and is in use? If such changes can be expected, training methods should be chosen and training materials developed with this in mind.

STAGE II

Stage II of the model is intended to be used in the actual development of the course, when the detailed decisions are made concerning learning activities for the students. The preparation of a Plan of Instruction, and Study Guides, Workbooks, and Lesson Plans are the major activities at this stage of the training development process.

The following is an outline of tne major headings in Stage II of the model:

INSTRUCTIONAL PERSONNEL

A. Instructor roles
B. Auxilliary instructional personnel needed
C. Instructional personnel management

STUDENT CHARACTERISTICS

A. Aptitude level of students
B. Special skills or characteristics required of students
C. Sex of students
D. Student motivation problems
E. Student management

TRAINING CONTENT

Kinds of learning activities needed in the training

1. Recall and application of facts
2. Serial procedures
3. Tracking and aiming
4. Searching and scanning
5. Discrete or continuous performance
6. Noise filtering
7. Skilled actions
8. Discrimination behavior
9. Complex perceptual-motor behavior
10. Problem solving

STAGE II

Notes on
<u>Training Approach</u>

Notes on
<u>Training Setting</u>

INSTRUCTIONAL PERSONNEL

A. What kinds of activities will the instructors be required to carry out in the instructional system to be developed? Both the training content involved and the training approaches chosen will affect the roles instructors fill in the instructional system. The following list describes some possible roles for instructors; others should be added if necessary:
   - Managing the instructional system (assigning students to learning activities, monitoring training equipment utilization, etc.)
   - Evaluation of student performance (for example, proficiency testing)
   - Monitoring student performance (and intervening when necessary)
   - Presentation of instruction (lecturing, demonstrating)
   - Planning and developing instruction (ISD activities)
   - Conducting discussions
   - Leading student activities
   -
   -

B. Will auxillary instructional personnel be required in the instructional system to be developed? The following list describes some possible kinds of auxillary instructional personnel; other kinds should be added to this list if needed:
   - Proctors (monitoring student activities but not intervening)
   - Administrative clerks (recording and processing data)
   - Training equipment operators and repairmen.
   - Computer operators and programmers
   -
   -

C. Instructional personnel management

   1. If the number of students is increased or decreased substantially, what will be the affect on the number of instructors required?

   2. Will special or additional training for instructors be required, for the training which is to be developed?

3. What provisions for instructor evaluation are to be made in the development of the training?

STUDENT CHARACTERISTICS

A. Aptitude levels of students

1. Will the students who are to enter this training be selected so that they fall in a particular range on the relevant aptitudes--high, middle, or low--or will they be at all levels of aptitude?

2. Will the students be selected for any special aptitudes other than the four standard Air Force aptitude areas (Administrative, Electronics, General, and Mechanical), such as athletic, verbal, clerical or spacial perception?

B. Special skills or characteristics required of students.

1. What reading level will be needed by students who are to enter the training?

2. What levels of vision, hearing, or other sensory acuities will be needed by the students? Will color vision be needed?

3. Will students need to be proficient in certain skills, or have had certain kinds of experience, in order to enter the training.

4. Are there any special characteristics needed, such as physical stamina, absence of fear of heights, volunteer status, Human Reliability criteria, absence of speech impediments, manual dexterity, exemplary appearance and bearing, unusual strength or size, etc.?

C. Sex of Students. Are students entering the training to be male or female, or both? Will this make any difference in the instruction or facilities required? Factors that might be involved include: different equipment or clothing requirements for women from men, or from those normally used by women; latrine facilities; quarters; etc.

D. Student Motivation. Is it likely that a significant number of the students entering training will be very poorly motivated because of malassignment, or for other reasons? Will provisions for counseling or otherwise dealing with such individuals be needed?

E. Student management

1. Will it be necessary to provide advance information on students' graduation dates, if a self-paced course of training is developed?

2. Will students be required to perform unrelated extra duties, details, etc. while they are in training?

3. Will it be important for students to finish training as soon as possible (in a self-paced course)? Can incentives be offered to students who finish training early?

4. How frequent are student absences from training activities likely to be? Should the training system provide opportunities for students to make up missed work?

TRAINING CONTENT

What kinds of learning activities should students engage in, to insure that they will be able to achieve the criterion objectives established for this training?

The numbered headings in the material below describe most of the kinds of activities that may be required. (Additional headings should be used if needed.) Under each heading is given two or three examples of that kind of performance. Then follows a guidance section which discusses the most important aspects of that kind of performance, to help in choosing appropriate learning activities.

1. Recall and application of facts

Examples: Making specific control settings on equipment from memory (Student must remember and use information on what the settings should be.)

Speaking (or writing) with reasonable fluency concerning an equipment system (Student must remember the terminology of the system, including the names and locations of the parts and controls.)

Completing forms required to show that prescribed maintenance activities have been accomplished (Student must remember the format and content of the information required to complete the forms, and where in the maintenance procedures or on the equipment this information can be obtained.)

Guidance: Activities requiring recall and application of facts are usually parts of larger procedures or activities. Therefore, when students must recall and apply facts, they will usually be working on sub-objectives (sometimes called secondary, enabling, or supporting objectives), rather than terminal or criterion objectives. Sometimes such sub-objectives will be adequately learned as a part of the larger performance specified by the criterion objective, and no special learning activities for the recall and application of facts will be needed. At times, however, it will be necessary to provide learning activities specifically designed to aid students in recalling and applying facts.

If special learning activities are needed to help students recall and apply facts, it is important that they "fit" the on-the-job performance. It may be tempting to require students to memorize lists of control settings, equipment terminology, or names of controls. However, such learning activities often do not "fit" the required on-the-job performance well enough so that what the student learns from these activities will be usable in carrying out the larger on-the-job performance.

If it is possible to have the student carry out learning activities in a setting very similar to the job, the learning activities will usually fit the job reasonably well. For example, a sub-objective may specify:

"Given a model XXX diesel engine in operating condition, the student will place the appropriate controls in the

> positions required so that the engine is ready to start. The student must place or insure that all controls are in the required positions in the proper order without reference to a manual or printed instructions, within one minute."

The activities described in this sub-objective obviously fit the on-the-job performance reasonably well.

However, it may often be more feasible to have students carry out learning activities away from the actual equipment or job situation to aid them in learning to recall and apply facts. In this case, it will take some care to insure that the learning activities fit the on-the-job performance. Requiring the student to "state orally or in writing the functions of the controls listed below" would involve learning activities which probably would not fit the on-the-job performance very well. When preparing to operate the engine, the student must decide (or have specified for him) the first general step to be accomplished, which in the example being discussed would be, "Start the engine." Next, the student would need to know what he must do to start the engine. Then the sub-objective given below would involve activities that generally fit the actual on-the-job performance, and would require the student to recall and apply the needed information.

> "The student will specify orally or in writing the controls of the model XXX diesel engine which are involved in starting the engine, and the positions to which these controls must be set so that the engine is ready to start. The student must specify the controls and the positions to which they must be set in the order in which the controls must be set to prepare the engine for starting. The student is to do this without reference to a manual or printed instructions, within one minute."

Specifically, in this case fitting the actual on-the-job performance means that the general cues or instructions at the beginning of the activities are the same or very similar, and that the order of the activities performed is

the same as would be required in the actual on-the-job performance. Actually, the performance required by this sub-objective would probably be somewhat more difficult than performance of the earlier sub-objective on the engine itself, because the cues provided by the parts of the engine would be missing. Many of these cues could be provided with pictures or drawings of the engine, if desired.

Learning activities for the second and third examples given above are indicated in the sub-objectives below:

> "The student shall be able to report orally to his supervisor (or instructor) the following kinds of information about the equipment:
>
> a broken part
> description of symptoms of common malfunction
> obvious failure of the equipment to perform as it should
>
> The reports shall be brief and clearly understandable, using accepted terminology for the equipment."
>
> "Given a copy of the appropriate form for recording maintenance work done on the equipment, on which selected spaces are marked, the student will be able to go to the equipment (or to manuals describing the maintenance procedures), determine the information required, and properly enter it in the marked spaces on the form. The student will accomplish this task in X minutes."

2. Serial procedures may be either fixed or branching.

   Examples of fixed serial procedures:

   Energizing a radar set

   Crew drill in an air defense missile unit

   Examples of variable or branching serial procedures:

   Troubleshooting complex electronic equipment using proceduralized methods and job aids.

Emergency procedures, which often involve branching away from otherwise fixed serial procedures.

Guidance: Serial procedures involve a series of steps, each individual step being relatively simple to carry out. The learning involved in serial procedures is learning what follows what, or chaining of responses. On-the-job serial procedures are likely to involve both verbal and motor chains. Verbal chains would involve, for example, remembering by means of verbal associations which step comes next at each stage of the procedure. Motor chaining would be involved in the actual performance of each step of the procedure, one after the other, in a smooth and reasonably rapid fashion.

In the early stages of learning a serial procedure, a printed or written list of steps may be used to prompt the student as he or she goes through the procedure. The person performing the procedure on-the-job must be able to do so without looking at such a list. Therefore, the student must learn the procedure. It may be helpful in learning the procedure for the student to verbalize the next step before performing it, but verbalization should always be kept subordinate to the actual performance of the procedure. Nearly always, simply memorizing a list of steps would be an inefficient and inadequate learning activity for serial procedures.

If expensive equipment is involved in the serial procedure to be learned, this equipment may be represented during the early stages of learning by very simple and inexpensive drawings. A line drawing of the parts of the equipment used in the procedure, together with a script or schedule that describes what happens as each step of the procedure is carried out, can serve the student very well during much of the time spent learning a serial procedure. The student can point to the drawing and describe the action to be taken at each step of the procedure. In the final stages of learning, some practice on the equipment itself will nearly always be required.

In variable or branching procedures, the branching or decision points are important added elements. The important things to be learned

about these decision points are the cues that give information as to the next step that should be performed, and of course the set of steps among which a choice must be made at each decision point.

3. Tracking and Aiming

Examples: Tracking a target on radar or with an optical sighting system

Steering a boat to follow a compass course

Aiming a weapon

Guidance: Whether a moving target is tracked for some period of time (seconds or minutes) or a weapon is aimed at a stationary target, the activity involves continuously changing cues which must be used to guide the tracking or aiming. The only way that these cues can be presented to the learner with any degree of realism is to have the learner track or aim at the target. Thus the learner must perform the activity of tracking or aiming to learn it.

The second point to be noted in connection with tracking or aiming activities is that the learner must have feedback, i.e., some kind of information that tells him how accurate his performance is. In manual tracking on a radar system, an indication of some kind is provided on a scope so the operator can see how he is doing. As you steer a boat, you can see whether the compass pointer is on the desired course or not, and make corrections as needed. When you aim and fire a weapon, usually you are able to see whether you have hit your target or not. If you do not know where on the target your shots are hitting, learning to shoot more accurately is almost impossible.

4. Searching and scanning

Examples: Aircraft detection

Aerial observation

Guidance: Searching may be described as examining an extensive area looking for certain kinds of objects or patterns. Scanning is a quick search, subordinate to some other task, such as scanning the instrument panel while driving a car.

The two most important elements in effective searching and scanning behavior are an organized system or routine for searching, and a knowledge of the objects or patterns to be detected. Preliminary familiarization with the objects or patterns to be detected may be given away from a job-like setting by the use of pictures or drawings. Likewise, preliminary instruction on a system or routine for searching can be given in a classroom or other non-job setting. However, these two elements need to be combined in some practice in a job-like setting, in order to be sure that the student is able to perform competently.

5. Discrete or continuous performance

Discrete performances involve a series of steps, where the steps can be described and performed separately.

Examples of discrete performances:

Operating control panels in missile systems

Assembly and disassembly of equipment

Continuous performances cannot be divided into clearly separate steps, and are usually guided and controlled by visual and muscular feedback.

Examples of continuous performances:

Aligning or adjusting electronic equipment

Riding a bicycle

Guidance: Discrete performance has a great deal in common with serial procedures, and the guidance offered under that heading also applies here. However, some kinds of discrete performances may involve steps which are not so simple and easy that the student can readily perform them as soon as he knows what is to be done. In this case, since such steps can be separated from the rest of the performance, specific instruction and practice on these steps may be provided as necessary. The student should be familiar with the overall performance when he or she practices a particularly difficult step, since this overall familiarity helps provide a context for the step, and should make it obvious to the student that this step must be

learned if the whole performance is to be successfully accomplished.

Continuous performance is a part of many on-the-job performances. The most important feature of continuous performance is that it depends on visual and muscular feedback—the continuous flow of information from the eyes and muscles that tells the brain how well the performance is going, by comparison to some standard or goal. Thus in adjusting electronic equipment, one often looks at a meter or oscilloscope while performing a manual adjustment on the equipment. Both the information that the eyes provide from the meter or oscilloscope, and the information that the muscle sense provides about the adjustment being made ("just a hair more, now") are necessary to obtain the reading on the meter or the pattern on the oscilloscope that tells the student that the adjustment is satisfactorily completed. In riding a bicycle, the eyes provide information about the path ahead and the muscles provide information about the movements made to control the bicycle. In this case, additional information is provided by the sense of balance, which must be integrated with the information provided by the eyes and muscles in order to ride the bicycle in a smooth and controlled fashion.

For training purposes, the important conclusion that should be drawn from this discussion of visual and muscular feedback is that the learner must actually perform the continuous activity so that he or she can experience this feedback and learn to respond to it in producing and controlling the desired continuous performance. Simply telling the learner about the performance, or having the learner observe another person performing, will be quite inadequate for teaching any but the simplest continuous performances.

6. Noise filtering - detecting cues or symptoms among background of extraneous stimulation

   Examples: Listening to an engine to detect indications of malfunctions

   Detection of targets on a radar scope.

Guidance: Attention should be focused on the cues or symptoms that are to be detected. If the equipment or situation can be manipulated so that the cues or symptoms can be presented

clearly with a minimum of extraneous stimulation, this would be desirable. When the students have had a chance to perceive the cues or symptoms under these conditions, extraneous stimulation can be introduced to produce the situation that would typically be encountered on the job, and the students could practice, and be tested, on their ability to correctly perceive the cues or symptoms in this situation.

If it is not practical to focus attention on the cues or symptoms in the manner described above, it may be possible to present the student with two different versions of the normal on-the-job situation. In one version, things would be operating normally, with none of the cues or symptoms present. In the second version, the cues or symptoms would be present and the contrast between the two versions, even if rather subtle, should enable the student to focus on the cues or symptoms he or she is to learn to detect.

Noise filtering usually involves detecting sounds or visual patterns. An analogous kind of activity would be involved in selecting relevant information out of a welter of irrelevant information and stimulation, as when an officer must extract the relevant facts concerning an instance of disorderly behavior in his or her subordinates, before deciding on disciplinary or other action. However, the abstract, conceptual nature of this activity properly places it in the problem solving category, and the guidance presented under this category would be more applicable.

7. <u>Skilled actions</u> -- activities that the untrained person cannot perform satisfactorily, even if told what to do.

   Examples: Clutching and shifting an automobile with a manual transmission.

   Precision measurement with a micrometer.

<u>Guidance</u>: The skill involved in activities of the kind to be discussed here is the skill required to carry out complex motor performances smoothly and precisely. Vision may guide the grosser elements of such performances, but smooth, precise performance depends heavily on learning to respond

to the feedback provided by the muscle sense. This is sometimes referred to as getting the "feel" of a task. Because the learner must experience this feedback from the muscle sense, in order to learn to respond to it with smooth and precise performance, the learner must practice the performance under conditions realistic enough to provide this feedback.

Skilled actions, as defined above, may be contrasted with actions which the learner can readily perform as soon as he knows what is required, such as placing a switch in a specified position, or adjusting a control so that a specified reading is obtained on a meter. Most serial procedures involving discrete performance consist mainly of steps that the learner can easily perform if he knows, or is told what to do. Steps that are not so performed by the learner will be skilled actions which require the specific and additional practice referred to in the discussion of discrete performance.

The precise coordination and timing of the several actions involved in clutching and shifting a manual transmission automobile or truck must be learned by practice which allows the learner to experience the feedback from the muscle sense and to learn to guide and modulate the actions in response to this feedback. Engaging the clutch smoothly depends particularly on this feedback. In learning to make precise measurements with a micrometer, the learner must learn to respond to the "feel" of the instrument as he manipulates it, in order to make consistent, accurate measurements.

8. Discrimination behavior -- recognizing differences between objects, indications or examples so that different responses can be made to them.

Examples: Aircraft, tank, or automobile identification

Selecting one answer, example or object (Solder joint, for example) as the "best" or "correct" one, according to certain standards.

Guidance: The particular elements that are needed to make discriminations should be highlighted in training. Thus, the distinctive features of different aircraft, tanks, or automobiles that are most useful in identification should be pointed out to the student, and practice can be provided with views of the aircraft, tanks, or automobiles in which these features are present. Early in training it may be worthwhile to use views in which these features are particularly prominent. However, such obvious prompting should soon be reduced so that most of the practice and all of the testing are done with views that are representative of actual field conditions.

When the discrimination behavior involves determining whether an item meets a standard, the specifications contained in that standard must be emphasized. Beyond this, however, the student must be able to evaluate the features of the item referred to in the standard and determine whether they meet the specifications. Simply being able to recite the specifications contained in the standard is inadequate; the student must be able to observe the items to be evaluated, and discriminate with the required accuracy those that meet the standard from those that don't. Training for discrimination behavior should therefore include practice and testing using actual examples of the items to be evaluated. The items used in this training should show a range of quality similar to that expected on the job, with the important additional proviso that the unsatisfactory items used in this training should exhibit all important defects that have any significant probability of appearing in the real-life situation.

9. Complex perceptual-motor behavior

Examples: Driving a car

Flying an airplane

Guidance: Complex perceptual-motor behavior makes more demands upon training methods and approaches than any kind of performance so far discussed. It may often contain within it many of the kinds of performance described above. Therefore the guidance presented above will be applicable in developing training for complex perceptual-motor behavior, whenever the various kinds of performance discussed above can be identified.

In dealing with the whole problem of training complex perceptual-motor behavior, it may be useful to think of it in three parts:

(a) Giving the student a familiarization with the whole performance, so that the student will have a general frameowrk into which to fit the several more specific kinds of performance that may be involved.

(b) Analyzing the performance to see what parts of it can be extracted for part-training.

(c) Integrating the part-performances into a smooth, proficient overall performance.

Thus, in teaching people to drive a car, it can usually be taken for granted that the American adolescent already has a pretty good general understanding of what is involved in driving a car, including traffic regulations and signals as well as the actual operation of the vehicle. However, if one were training native laborers in an undeveloped part of the world to drive trucks, attention would have to be paid to providing the trainees with some overall framework for understanding the whole performance expected of them after training.

It is likely that many beginning flying students would think only of the activities involved in controlling the aircraft in flight. Therefore, it would be necessary to familiarize them with other elements of the whole performance, such as airspace and route regulations, navigation, communications procedures, aircraft instruments and the uses made of the information they provide, preflight procedures, etc.

In driver training, the information concerning traffic regulations and signals, which is ordinarily covered in the written part of the driver's license examination, can readily be taught separately from the actual operation of the vehicle. In flying training, various kinds of information and regulations are taught in "ground school," before the students learn to operate the aircraft. Usually, whenever knowledge or skill components can reasonably be extracted from the whole complex perceptual-motor performance and taught separately, consideration should be given to doing this. In the case of driving

or flying training, it is obviously important that students learn the general framework of traffic and safety regulations and procedures before they practice the full-fledged perceptual-motor behaivor of driving or flying. In other cases, it may be important that specific, additional practice be given in certain skills, such as parallel parking a car or making an approach to an airport, during the learning of the whole performance.

Complex perceptual-motor behavior involves coordinating information obtained via the eyes, ears and other senses to direct motor activity, and the feedback of information from the muscle sense and the sense of balance to control the movements being made. Therefore, it must be practiced in a reasonably complete form with the actual equipment used on the job, or on a relatively high-fidelity simulator, if all important elements of both the perceptual and motor aspects of the performance are to be produced in the learner, so that the various part-performances can be integrated into a smooth, proficient overall performance. Driving is usually practiced in the real equipment -- cars. But flying, and particularly emergency procedures, is often practiced in elaborate simulators because of cost and safety considerations. Elaborate and costly simulators can be better justified for training complex perceptual-motor behavior than for any other kind of learning.

10. Problem solving -- recall and application of concepts and principles.

Examples: Troubleshooting complex equipment without proceduralized methods and job aids.

Selecting a supervisor for a group of workers.

Guidance: Problem solving behavior may be divided into two classes; reproductive problem solving--the repeated solving of problems, all of the same class; and productive problem solving, a more general kind of problem solving in which various approaches and methods must be tried until one is found that satisfactorily solves the problem.

Notes on
Training Approach

Notes on
Training Setting

The training of reproductive problem solving can be disposed of quickly. A particular method of solution can be chosen and designated as the "correct" method for solving a particular class of problems. This method can then be taught and the students given practice in applying it. Weight and balance computation for a particular transport aircraft is an example of this kind of problem solving. It is important in training this kind of problem solving behavior to give the students practice on a variety of problems, using values extending over the ranges likely to be encountered in on-the-job situations.

Productive problem solving behavior depends on knowing the concepts and principles (or rules) that are applicable in the area of work, and on being able to combine and manipulate these concepts and principles in various ways until a satisfactory solution is found. Knowledge of the applicable concepts and principles will often depend in part on earlier education before the students entered military service, so that the capabilities of students entering training must be carefully assessed--are they proficient in algebraic operations? Are they acquainted with the general principles of operation of spark-ignited internal combustion engines? Building on the students' prior knowledge, the additional concepts and principles needed to solve problems in a given area must be taught, preferably in the context of work in the area, rather than as a separate preliminary block of instruction in, for example, electronics fundamentals.

The manipulation of concepts and principles in problem solving behavior occurs, for the most part, internally or "mentally", and therefore cannot be observed. One must observe the overt actions the student takes as a result of this concept and principle manipulation, and determine whether these overt actions adequately solve the problem.

A person's ability to manipulate concepts and principles depends heavily on attitudes and intellectual skills developed over years of

experience. Is the person excited or challenged by the problem? What kinds of information gathering and organizing habits has the person developed? Does the person "keep loose" in his or her thinking and is therefore able to shift readily from unpromising approaches to more promising ones? Or does the person tend to fixate on a particular method or approach and rigidly persist in trying to use it?

Research has shown that simply showing students the solutions to particular problems does not work very well as a method of training them to solve other problems that are somewhat different. The best methods appear to involve a kind of guided or prompted discovery process actively carried out by the students. The kinds of guidance that appear to be most useful in developing problem solving behavior are as follows:

(a) guidance that warns against using approaches that will be unsuccessful

(b) guidance that suggests the <u>general</u> nature of approaches that will be successful, without telling the student precisely how to solve the problem.

To illustrate these guidelines for teaching problem solving behavior, the relatively simple problem of a gasoline engine that will not start will be discussed. Assume that the engine has recently been operated and that no catastrophe such as total loss of lubricating oil has occurred, so that major mechanical difficulties such as frozen pistons or seized bearings are not likely causes of the problem. A knowledge of the concepts and principles involved in a spark ignited internal combustion engine should enable the student to identify three likely areas in which the problem solution might be found: battery and starter system, fuel supply and carburator operation, and ignition system. Accordingly, the student should first determine whether the starter will turn the engine over. If it will not, possible reasons such as a dead battery or a faulty electrical circuit to the starter motor should be investigated. If the engine will turn over, attention should be directed to the other systems. Is a spark being delivered to the spark plugs by the ignition system? Are the spark plugs

shorted? Is the engine out of fuel? Is fuel getting to the carburetor? Is the fuel pump operating? Is the choke closed (for a cold engine)? Is there excess gasoline in the carburetor ("flooded")? The student will need to understand the meanings of such questions and know where and how to obtain the information to answer them. Questions or prompts of various kinds may be used to nudge the student down the path to discovering the reason that the engine will not start. Essentially, the student must engage in the process of organizing and directing his information seeking efforts (which is mainly a covert or internal process), and must know what should be done if certain conditions are found, if he or she is to develop any generalized problem solving capability in this area.

As a second illustration of how problem solving may be taught, consider a problem from a very different area, that of selecting a supervisor for a group of workers. Problem solving in this area would usually be taught by using hypothetical cases to stimulate the covert manipulation of concepts and principles in which the students must engage. The students would be given information about the kind of work done by the group of workers, and perhaps some general restrictions within which the problem was to be solved. Attention might then be directed to the question: What do you expect the supervisor to do? Discussion of possible answers to this question should define the concept of supervision to be used in this case. Must the supervisor be expert in performing the work done by the workers? Does the supervisor organize the work group and assign work, based on requirements handed down from higher management? Does the supervisor represent the workers in the group to higher management levels, arguing for them in matters that affect the group? Etc. Attention might then be turned to the characteristics of the candidates for the job of supervisor. The students should be encouraged to obtain information on each of the candidates that is relevant to the elements of

the concept of supervision, and to compare the characteristics of each candidate with performance requirements implicit in the concept of supervision decided upon. The question that should be asked (usually covertly) in making these comparisons is "Can this candidate perform acceptably as we expect a supervisor should?"

These two examples are relatively simple and structured, compared to many kinds of productive problem solving. Sometimes the manipulation of concepts and principles must proceed over quite uncharted ground. The important thing in training for problem solving, however, is that students must be stimulated to engage in this manipulation under circumstances that are similar to those that will be involved in problem solving situations on the job.

REFERENCES

Air Training Command, USAF, Training Plans, ATC Manual 52-1, 15 September 1969.

Department of the Air Force, AF Pamphlet 50-58, Handbook for Designers of Instructional Systems. 15 July 1973.

Department of the Air Force, AF Manual 50-2, Instructional System Development, 31 July 1975.

Gagne, Robert M. The Conditions of Learning (2nd edition), New York: Holt, Rinehart and Winston, 1970.

Gagne, Robert M. and Briggs. Leslie J. Principles of Instructional Design. New York: Holt, Rinehart and Winston, 1974.

Haverland, Edgar M. Transfer and Use of Training Technology: A Model for Matching Training Approaches with Training Technology, Alexandria, Va.: Human Resources Research Organization, Technical Report 74-24, October 1974.

Haverland, Edgar M. and Hungerland, Jacklyn E. Transfer and Use of Training Technology in Air Force Technical Training: A Progress Report. Alexandria, Va.: Human Resources Research Organization, Interim Scientific Report IR-ED-75-24, October 1975.

Hungerland, Jacklyn E., Taylor, John E., and Brennan, Mark F. Utilization of Peer Instruction in Air Force Technical Training. Alexandria, Va.: Human Resources Research Organization, Final Report FR-WD-CA-76-12, August 1976.

Weingarten, Kenneth, Hungerland, Jacklyn E., and Brennan, Mark F. Development and Implementation of a Quality-Assured, Peer-Instructional Model. Alexandria, Va.: Human Resources Research Organization, Technical Report 72-35, November 1972.